# STUDY OF THE DUCTAL PATTERN OF PANCREAS IN 50 SPECIMENS

*Dissertation submitted in partial fulfillment of the requirement for the award of*

**M.S. DEGREE EXAMINATION**
**(ANATOMY)**

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# CERTIFICATE

This is to certify that the dissertation entitled **"STUDY OF THE DUCTAL PATTERN OF PANCREAS"** submitted by **Dr.DH.Gopalan,** postgraduate in Anatomy to the faculty of Anatomy, The Tamilnadu Dr. M.G.R Medical University, Chennai in partial fulfillment of the requirement for the award of M.S. Degree in Anatomy, is a bonafide work carried out by him under my direct supervision and guidance.

Place: Madurai

Date:

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# DECLARATION

I, **Dr.D.H.GOPALAN** solemnly declare that the dissertation entitled "**STUDY OF THE DUCTAL PATTERN OF PANCREAS IN 50 SPECIMENS"** has been prepared by me under the guidance and supervision of **Dr.V.RAJARAM D.L.O., M.S.**, Director & Professor I/C, Institute of Anatomy, Madurai Medical college, Madurai in partial fulfillment of the requirement for the award of **M.S. (Anatomy)** Degree Examination of **The Tamilnadu Dr. M.G.R Medical University, Chennai** to be held in March 2010. This work has not formed the basis for the award of any other degree to me from any other university.

Place: **Madurai** **Dr. D.H.Gopalan**
Date:

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# INTRODUCTION

Pancreas is a Compound racemose gland ,analogous in its structure to the salivary glands, though softer and less compactly arranged than the above organs. It is composed of two quite separate types of glandular tissue which are however in intimate topographic association with each other. The main mass of the tissue is exocrine part of pancreas embedded in which clusters of endocrine cells constituting the Pancreatic Islets.

Ductal pattern of Pancreas is important because of its implications in various fields of Medicine. It is an interesting topic for the Anatomists because most of the clinically important variations will be clearly analyzed by them under Embryological basis.

The knowledge about the Normal Ductal pattern as well as the congenital variations are very much important for the Surgeon according to which he can modify the surgical procedure in a more satisfactory way. This will help him to prevent most of the common post operative complications like pancreatitis. Radiological procedures like Endoscopic

retrograde Pancreaticography itself can leave chronic recurrent pancreatitis.

More than 75% of the adenocarcinomas, which is the most common pancreatic malignancy arise from the ducts. Operative loosening of proximal part of duodenum may sometimes injure the accessory pancreatic duct. In cases where the accessory duct is the main excretory route this may cause post operative pancreatitis which is an acute emergency. A patient with an obstructive lesion of main pancreatic duct either with a tumor or stone may not develop any symptom if the accessory duct is patent.

As science advanced procedures like Percutaneous Pancreatography and Endoscopic Pancreatography (EPR) became widely accepted invaise techniques. Ultrasound guided Percutaneous Pancreatography with fine needle may be under taken when EPR fails to demonstrate pancreatic ducts. At present Magnetic Resonance Pancreatography, a non invasive technique is very commonly being used.

This is used to delineate the segments of ducts which are not evaluated by EPR.

The condition called Pancreatic Divisum is associated with chronic pancreatits. There is no doubt that the patient will yield abnormal pancreatograms which may be mistaken for a pancreatic disease. This may lead to misinterpretation of ultrasonic and CT findings. The knowledge of the existence of these anomalies and the ductal pattern in them is helpful for an endoscopist for the correct interpretation and is helpful to the surgeon contemplating pancreatic surgery and may be a factor in deciding the surgical procedure to be carried out. In Pediatric Patients some of the serious conditions like Mongolism, Cardiac defects, Intestinal Malrotation, Ductal Atresia and Tracheo Oesophagial fistula are being noted in association with pancreatic divisum, iatrogenic pancreatitis also is associated with this condition.

***Retro pancreatic position*** of common bile duct is clinically important because it is being often subjected to operative exploration. This topic is of primary interest to every biliary surgeon for as stated by the Late Lahey of Bostin- “We urgently need more investigation on the retro pancreatic part of bile duct”.

***Pancreatico biliary ductal union*** is a complex anatomical and functional entity. Anomalous Pancreatico Billiary Ductal union or

common duct with more that 12mm length is reported to be associated with cystic dilation of gallbladder and carcinoma of gallbladder.

Common channel with more than 3mm in length is always associated with reflux pancreatitis in a case of block.

Because of the above clinical significance the topic for chosen for study.

# AIM

**To study**

a) Ductual pattern of pancreas

b) Retro Pancreatic Positioning of bile duct

c) Pancreatico biliary ductal union

The study was conducted in 50 specimens of both sexes.

# REVIEW OF LITERATURE

## DUCTAL PATTERN OF PANCREAS:

Johann George Wirsung (1589-1643), the prosector of Padua-Italy, discovered the human pancreatic duct in 1642 during the dissection of an executed murderer. Instead of publishing his work he engraved a drawing of the duct in a copper plate, from which seven or more imprints were taken. The copies were sent to the leading Anatomists in Europe with the question-'Should I call it an artery or vein? I never found blood in it' Wirsung was assassinated subsequently. Three and half a Centuries later Haward J.M.HessW & Transverso.W traced Six copies of "Ductus Wirsungianus". Copper plate remains well preserved. His findings had opened a new field of Medicine.

Santorini (1775), the Italian Anatomist was the first to describe the Anatomy of accessory pancreatic duct and minor duodenal papilla. He gave the first accurate concept regarding the relations of bile duct and pancreatic duct to each other and two papillae through which they discharge their contents into the duodenum.

Since from the time of reporting, the Anatomy of pancreatic ducts were studied by so many devoted workers.

Claud Bernard (18560 resuscitated Santorini's work and by injections of metallic mercury into bile and pancreatic ducts, he determined their mode of termination and function.

Opie (1903), one of the great American pathologists stated that in 10% of 100 cases the duct of Santorini was functionally as well as structurally the chief outlet of exocrine pancreatic secretion.

Baldwin of university of Cornell (1911), presented a major pioneer investigate work on the pancreatic ducts. According to him in 82% of 100 cases the accessory duct is patent ventral to that of main pancreatic duct and is restricted to its cephalic and ventral segments of head, its orifice (minor papilla) being cephaloventral to that of the major duodenal papilla on a transverse mucous membrane fold.

Shwartz of University of Heiddilberg (1926) after an examination of 64 cases, reported that santorini's system was missing in 25 cases and was the sole outlet in 3 cases and was rudimentary in another 3. It communicated with the Duct of Wirsung in 23 cases and was independent

in 8 cases. He said that in all cases the duct of Santorini was demonstrated in the head of pancreas ventral to the duct of Wirsung.

Simkin's (1931) studied in detail the duct of santorini in 25 specimens and quoted that in 10% cases the duct of santorini was the chief outlet of pancreatic exocrine secretion. In a study conducted in the Philadelphia general hospital he described 3 groups of Santorini.

1) Santorini's duct present only in Cephalic part of head.
2) Santorini's duct confined to the Caudal part of head.
3) Distributed both in Caudal and Cephalic part of head.

Naetamen of the University of Helsinki (1941) investigated the ductal pattern in 100 specimens in which he injected a coloured fluid into the ductal system. In 20% only he demonstrated a patent accessory pancreatic duct. So according to him if the duct of Wirsung is getting obstructed by a stone or tumour 1 in every $5^{th}$ case only the gland was able to excrete the secretions into the duodenum through the above patent duct.

The ductal pattern was studied in detail again by Rienhaff and Pickrell (1945). They observed that only in 4 cases out of 100 the accessory duct carried the major secretion. According to them the

Santorini’s duct lies on a plane ventral to that of main duct and communicates with it in the head of pancreas near the neck region.

As years advanced the dedicated workers started using different colouring fluids and dyes for pancreatographic techniques and they started using the radiological methods apart from the routine postmortem dissection or the cadaver dissection.

Hjorth (1947) claimed a sex difference in the patency of santorini. He found an open communication of Santorini with duodenum in 44% cases in men and 14% in women. He tried to explain the association with the occurrence of biliary diseases more in women. Santorini’s duct in open communication with duodenum would act like a safety valve for increased pressure in the pancreatic duct and this reduces the possibility of reflux of pancreatic juice into the common bile duct.

In 1950s the study was conducted by so many Anatomists and most presented a common percentage of 90 where the Duct of Wirsung is the main excretory route. One important among this was of Berker (1950) and in his study he pointed out that the junction of ducts of Wirsung and Santorini represents a weak point in the pancreatic drainage system and is prone for obstruction. If the accessory duct is having no opening in the

duodenum, it will empty its contents into the main duct against the direct of flow.

Erik Millbourn of University of Laud, Sweden (1950) has presented the most extensive investigation on the Anatomy of pancreatic ducts. To get the full display of pancreatic ducts he made a closure of pancreatic orifice in duodenum by sewing it up. There upon injected a 20% Barium sulphate solution into the bile duct and gave supplementary injections into the main duct from the tail of pancreas. The contrast injected specimens were studied in X-ray films and in gross dissection.

From his studies Erik Millbourn concluded that the sole or main excretory channel of pancreatic parenchyma is the duct of Wirsung in about 90% cases and the duct of Santorini in about 10% cases. Santorini's duct invariably courses ventral to the duct of Wirsung and terminate at the lesser papilla situated Cephalo ventral to the greater papilla. He found no sex difference as claimed by Hjorth (1947).

Berman (1960) studied multiple variations of pancreatic ductal pattern in relation to the common bile duct. His findings were based on the study of ductal system in Man by the use of vinyl acetate casts of postmortem preparations and dissections of pancreatic duct in 200

specimens. According to his report in 90% cases the major pancreatic duct was the main excretory route and in 10% of cases the accessory pancreatic duct was the chief excretory route.

Dawson W. and L.Langman (1961) did a study about the ductal pattern in 100 specimens and he divided them into 3 groups.

1) Where both ducts are patent
2) Where ansa pancreaticus is present
3) Where the accessory duct is obliterated either proximally or distally.

Recently the development of techniques like Endoscopic Retrograde Cholangio Pancreatography (ERCP) and Magnetic Resonance Cholangio Pancreatography (MRCP) had enabled the demonstration of pancreatic duct system in a large number of patients.

Reports by Cotton and Kiju (1976) had shown that the pancreatitis was present in a high proportion of patients with an unfused pancreatic duct system and suggested that the anomaly might be the cause of pancreatitis.

Varly P.F and Rohman C.A (1976) using Endoscopic pancreatograms studied the precise details of the ductal course in Thai people.

Willarumec. C & Pongichirecks. P (1999) studied the ductal pattern in Thai people by the injection of methylene blue and showed that in majority (90%) the main route of excretion is the main duct. The accessory pancreatic duct functions as the main channel in 10% people.

Morgan DE & Logan K (1999) in a study based on ERCP stated that in a group of people referred for ERCP, the prevalence of pancreatitis was very high in patients with pancreatic divisum and was limited to a doral distribution.

Yokohate.K & Shirakana K (2000) stated that the dilatation of ductal branches depicted by MRCP might be a hint for early detection of pancreatic malignancy.

Ductal patterns in clinically important congenital anomalies were studied by so many workers. In annular pancreas from the head of pancreas an extension forms a complete or incomplete ring around the decending part ($2^{nd}$ part) of duodenum. Annular pancreas was first

described by Tiedemann, Professor of Anatomy at Hiedelberg University, Germany in 1818, Ecker (1862) gave it the name Annular Pancreas.

In their case report Mc Naught and Cox of the Standard University School of Medicine (1935) presented pancreatographic method for visualizing the duct system and noted that in 88 percent of 40 reviewed cases, the duct of annular pancreatic ring is a part of duct of Wirsung, this being a strong indication that annular pancreas is a developmental anomaly of ventral pancreas.

Lehman of University of Virginia School of Medicine (1942) analysed 48 cases of annular pancreas. Analysis showed that there was a constant anterior point of origin of the duct of the ring which was subsequently coursing to the right over duodenum, then posteriorly and to the left behind the duodenum, finally entering the head of pancreas in close relation to the common bile duct and joint the main pancreatic duct.

Millbourn (1950) from his observations suggested that most of the affected individuals are males in relation to Annular Pancreas.

Shapinker (1954) studied the duct pattern in annular pancreas and stated that modification of surgical procedure is needed to avoid injury to the duct. He advocated a retrocolic duodenojejunostomy as the most

satisfactory bypass operation. Other reported anomalies related to ductal system of pancreas are,

**1) Inversion of pancreatic ducts:** Here the embryonic pattern of duct persists and greater part of pancreas is drained through minor duodenal papilla.

**2) Pancreatic divisum (Divided pancreas):** The parts of pancreas derived from the dorsal and ventral buds fail to fuse with each other.

## *Distance between major & minor duodenal papillae:*

It was studied by so many workers as about the ductal pattern.

Lerulle and Nattan Larrier (1898) found variations of distance from 10 to 35 mm, the average being 20mm.

According to Baldwin (1911) the distance from the lesser to the greater papillae varies from 9 to 35 mm, the average being 20mm.

Sice of France (1911) reported a distance of 29mm in one case.

Claimant of Switzerland (1923) reported a distance of 3mm between the two papillae in one case.

Maeda (1950) found the distance to vary most frequently from 20 to 29 mm with extremes from 10 to 59mm.

Millbourn (1950) found the lesser papilla to lie oroventrally to the greater papilla. In his 200 specimens he found an average distance of 20mm between the two papillae.

Recently, Hughes and Kernutt of Australia (1954) found the distance between two papillae to be an average 21mm.

## *Retropancreatic positioning of common bile duct:*

Accessibility of the retro pancreatic bile duct for surgical exploration was studied by so many great workers.

Beginning with Lettille and Nattan Larrier of France (1898), who were among the first to talk about the laminar extension of pancreatic head over the retropancreatic part of bile duct, so many investigators started studying the Anatomy of Pancreatic part of Choledochus.

Nuboer, of the University of Utrecht (1931), reported that in 67% cases the common bile duct passed through a tunnel in pancreatic tissue, meaning that it was being covered by only a connecting tissue and in 33% it was not freely accessible.

In an examination of 100 specimens, Nattemen of University of Helrinki (1944) found the following relations of the common bile duct

1) It coursed in a furrow on the dorsal surface of the pancreas covered by connective tissue (53%).
2) It is covered by a thin sheath of pancreatic tissue (34%).
3) It coursed through a tunnel of pancreatic tissue (12%) which was closer to the dorsal surface of the pancreas.

Up until about 1945, it was believed generally that, as the common bile duct approached the second part of the duodenum in an oblique direction, in most of the individuals it passed through the head of pancreas in a complete or incomplete tunnel and thereby became an intraglandular structure not readily accessible or explorable without cutting the pancreatic tissue. But Dejhi & Fritas (1945) studied this topic and reported that in 60% of 100 specimens the retro pancreatic bile duct was easily accessible.

As shown by Smanio, of the Department of Anatomy of the School of Medicine of University of Sao Paulo, Brazil (1954) in 60% of cases the retropancreatic bile duct was easily accessible. In his summary Smanio stated that the choledochus in the retro pancreatic portion was easily accessible, either because it was not covered by pancreatic tissue or was so covered only in a small portion of its length or because it was covered

by two ‘lingulae’ (laminar extension of pancreatic tissue) the lips of which are juxtaposed to the level of posterior face of the duct.

In 40% cases the lingual was thick. Under these circumstances the isolation of bile duct was very difficult.

According to Smanio observations in both sexes showed no significant statistical variations related to position and accessibility of retropancreatic Bile duct.

## *Pancreatico bile union:*

The concept where by the common bile duct and main pancreatic duct are converted into a common channel is well established by most of the anatomists who investigated this region.

Whether the distal end of pancreatic duct and common bile duct are really forming a common channel or these are separated by a thin membrane till their openings into the duodenum was studied by so many workers.

The first accurate description and illustration of Ampulla of Vater in the rat was made by Professor H. gage of Coinell University (1878) and he published the same in the American Quaterly Microscopic Journal in 1879.

Little and Nattamlarrier (1898) of Paris among the first to classify and illustrate the various types of openings of the common bile duct and pancreatic duct into the duodenum. They published their article in the Bulletin of the Anatomical Society of Paris. They investigated 21 specimens previously treated for 24 hrs with Mullers fluid. The ductal openings according to them form so many groups.

1) The Two ducts joining in an acute angle but separated internally by a thin membrane and distally opening through a true common channel.
2) The two ducts are opening separately on a depression i.e., no ‘true’ common channel.
3) Two ducts are opening separately on a same plane.
4) No ampulla present.

Opie (1903) studied the mode of union in 100 specimens. He stated the presence of common channel in 89% and separate opening in 11%.

Archibald (1919) noted the average length of the common channel as 2mm. variations were from 2 to 10mm.

Baldurin (1911) carried out routine dissection in 90 specimens and reported a common channel in 78% and separate openings in 22%.

Pedro Belou, the professor of Anatomy at the University of Buenos Aires, Argentina in his classical monograph published in 1915 classified the terminal endings of bile and pancreatic duct as observed in 50 specimens in two groups.

1) Cases in which there was a common opening for the ducts in 62%.
2) The common channel was not demonstrated in 38%. The length of the common channel when it was present was from 3 to 7mm.

Cameron and Noble (1924) studied the pattern in 75 specimens by routine dissection method. They demonstrated common channel in 76% and separate openings in 19%. In the remaining specimens the main pancreatic duct became a fibrous strand and accessory pancreatic duct was the draining channel.

Couveliare (1934) after studying 100 specimens by routine dissection method found out that only in 49% cases had a common channel. All other specimens showed separate openings for the common bile duct and the main pancreatic duct.

According to Pfuhl (1936), the common channel is formed in the following manner. As the bile duct passes obliquely through the longitudinal and circular muscles of duodenal wall for 1 to 2 cm it is first

tapered, then after receiving the pancreatic duct it ends in a dilated ampulla.

Boyden (1937) on the embryological basis stated that the confluence of bile duct and pancreatic duct starts outside the duodenum, but in the course of development the zone of junction becomes drawn into the duodenal wall. He did a comparative study in opossums, guinea pig, dog and in man.

Naatanan (1941) worked out 100 specimens and described a common channel in 67% and demonstrated a separate channel in 33%. He noted the average length of common channel as 6mm with variations from 2 to 15mm.

Neboer of Berlin city Hospital (1931) reported a true common channel in 76% and separate openings in 19% out of 75 cases he studied.

Rienholff and pickrell (1945) of John Hopkins University after a study of 250 autopsy specimens noted the following types.

1) No union of pancreatic and bile duct, both entering the duodenum by a separate opening (29%).

2) The ducts were contiguous with the dividing thin septum terminating within 3mm from the apex of the duodenal papilla (37%).
3) True common channel varying from 3mm to 14mm in length from the apex of duodenal papilla and having an average diameter of 3mm (32%).
4) The main pancreatic duct is reduced into a fibrous strand (2%).

Hjorth (1947) from California studied 100 specimens with the help of cholangiographic methods. He injected a contrast medium under low pressure into the pancreatic duct and noting its reflux, course and its relations were visualised. He demonstrated a common channel in 86% and separate openings in 14%. Out of the 14% cases with separate openings 5% showed openings in the common major papilla. 9% showed separate points of opening into the duodenum.

Millbourn (1950) studied 200 specimens by injecting contrast material into the bile duct and using cholangrographic method. He reported a common duct in 85% and separate openings in 9%. In the rest the main duct was a fibrous cord.

Hotzapel of Dootmund of Germany (1950) reported the following types of duct orifices for bile and pancreatic duct.

1) Separate openings of two ducts in one papilla.
2) Separate openings of two ducts in two papilla.
3) Common opening in one papilla.

Hughes and Kernutt (1954) studied 30 specimens and demonstrated a common channel in 57% and separate openings in 37%. In the rest the pancreatic duct was a fibrous cord.

Brue, Walmikey & Ross have described in the Manual of Surgical Anatomy (1979) three variations in the termination of the ducts.

1) Two ducts unite to form a true common channel of length less than 3mm i.e. the Ampulla is absent.
2) The common channel length is more than 3mm i.e., ampulla can be defined.
3) The two ducts open separately either into a summit of a papilla or in a slight depression.

Variations were also described by Skandalkis (1979) after studying the pancreatico biliary ductal union. He described 3 groups.

- Long common channel of bile and pancreatic ducts.

- A short common channel.
- Open separately into duodenum.

A Japanese study group on **Pancreatico Biliary Maljunction** (1994) defined Anomalours Pancreatico Biliary Ductal Union (APBDU) as a congential anomaly where there is a connection of pancreatic duct and bile duct with an obviously long common channel (>12mm) or their union in an apparently anomalous form. In their studies they noted Anomalous Pancreatico Biliary Ductal Union (APBDU) has a prevalence of 1.5%-8.7% in Thai people. They divided the APBDU into 2 groups.

a) Biliary-pancreatic type (B-D) where common bile duct is joining the pancreatic duct.
b) Pancreatic-biliary type (P-B) where pancreatic duct is joining the bile duct.

K.B.Chauch, Y.K.Yap and H.S.Nag (2000) in a study based on Singapore population noted the average length of common channel as 4.5mm in 100 specimens. The variations were from 1 to 12mm.

Ronald A Bergan PhD (2001) studied the Pancreatico Biliary Ductal Union in 100 specimens. By routine dissection method in 63 specimens a common channel was demonstrated. 30 specimens in this study showed separate openings. And in the rest the main pancreatic duct was reduced into a fibrous cord.

# MATERIAL AND METHODS

**Materials:** 50 adult pancreas specimens were taken for the study. 20 specimens were collected from the cadavers in the Institute of Anatomy, Madurai Medical College. 30 specimens were collected from the Department of Forensic Medicine, Madurai Medical College, Madurai.

Specimens were collected from the cadavers in the dissection table. Pancreas was removed along with the duodenum and retropancreatic part of the bile duct.

Specimens collected from Forensic Medicine Department were cleaned in tap water and were put in 10% Formalin solution and were taken for dissection.

**Materials Used:**

- Stainless steel student's scalpel.
- Stainless steel forceps- toothed and non- toothed.
- Stainless steel long and short straight scissors.
- Knife.

- Black cream sheet, Rubber sheet, Graduated scale, HB pencil, 0.4mm thread and Cotton.
- Gloves and Apron
- Covered container for preserving specimens in formalin.
- 10% formalin.
- 20 ml syringe.

**Methods of Study**

1. Routine dissection of the Specimens to see the pattern of pancreatic ducts and mode of their opening into the 2$^{nd}$ part of duodenum.
2. Injection of air into the pancreatic duct in underwater dissection method to study the patency of the ducts.
3. Measurement of the distance between the major and minor duodenal papillae.
4. Measurement of the length of the common pancreatico-biliary channel.

**Method I (Routine Dissection)**

Specimens were cleaned by removing the remains of peritoneum and vessels which are closely attached to it and then washed thoroughly in tap water. On the posterior aspect of the pancreas the bile duct was traced down to the pancreaticobilliary junction at the 2$^{nd}$ part of Duodenum. While tracing down, retropancreatic positioning of the bile duct was also noted down. The major pancreatic duct was traced towards the tail end. Some of the main branches were also traced. The ducts were also traced up to the duodenal wall. The accessory pancreatic duct was traced up to the duodenal wall.

After this, a longitudinal incision was made on the posterior aspect of the 2$^{nd}$ part of the duodenum towards the right margin at the level where pancreaticobilliary ductal union approaches the duodenal wall. This incision was extended upwards and downwards. Flap was reflected medially by putting two horizontal incisions at the ends. Duodenal lumen was cleaned thoroughly in running water and the two papillae were located. From the posterior aspect photographs were taken.

**Method II (patency testing by injection of air in underwater dissection method )**

After the dissection, air was injected from the distal end of the ducts and patency of the major and minor ducts were noted with the appearance of air bubble at the papilla in underwater dissection method. If the air injected in the main duct was not entering the accessory duct separate injections were made in the distal end of that duct.

**Method III: Measuring the distance between 2 papillae**

In the lumen of duodenum the distance between the two papilla was measured using a thread and scale. The thread was placed on the major duodenal papilla and the other was stretched towards the level of minor papilla and markings were made on the thread. The marked distance was measured using a scale.

**Method IV: Measuring the length of common channel**

A clean slit was made on the bile duct little away from the union of pancreatic duct the incision was extended down and the duct was traced up to the opening in the duodenal mucosa. The following things were studied in this procedure.

a. Whether there is any septum separating the two ducts till a very small distance from the papilla.
b. Whether the two ducts are opening separately into the duodenal lumen.
c. The length of the true common channel was measured using a thread and scale. The thread was marked after keeping it straight from the duodenal papilla to the point of starting of the true common channel. Marked thread was measured using the scale.

# OBSERVATIONS

The total 50 specimens were studied by dissection method.

The following observations were made during the study.

## A) Mode of Formation of Pancreatic duct

In all the specimens the main duct was formed in the tail end of pancreas by the union of smaller ducts alternatively from either side giving a ‘herring bone’ pattern (Figure 3). As it goes towards the head end of the pancreas the caliber of the duct was increasing. Branches of the main duct showed similar pattern. The main pancreatic duct was receiving branches from tail, body, neck, postero inferior aspect of head and uncinate process of pancreas. The accessory duct was receiving branches from superior part and antero inferior part of head of the pancreas.

## B) Position of pancreatic duct

Inside the pancreatic tissue the main pancreatic duct was placed posteriorly towards the superior border. Accessory duct when present was placed anterior as well as cranial to the main duct.

## C) The Mode of Drainage of Exocrine pancreas

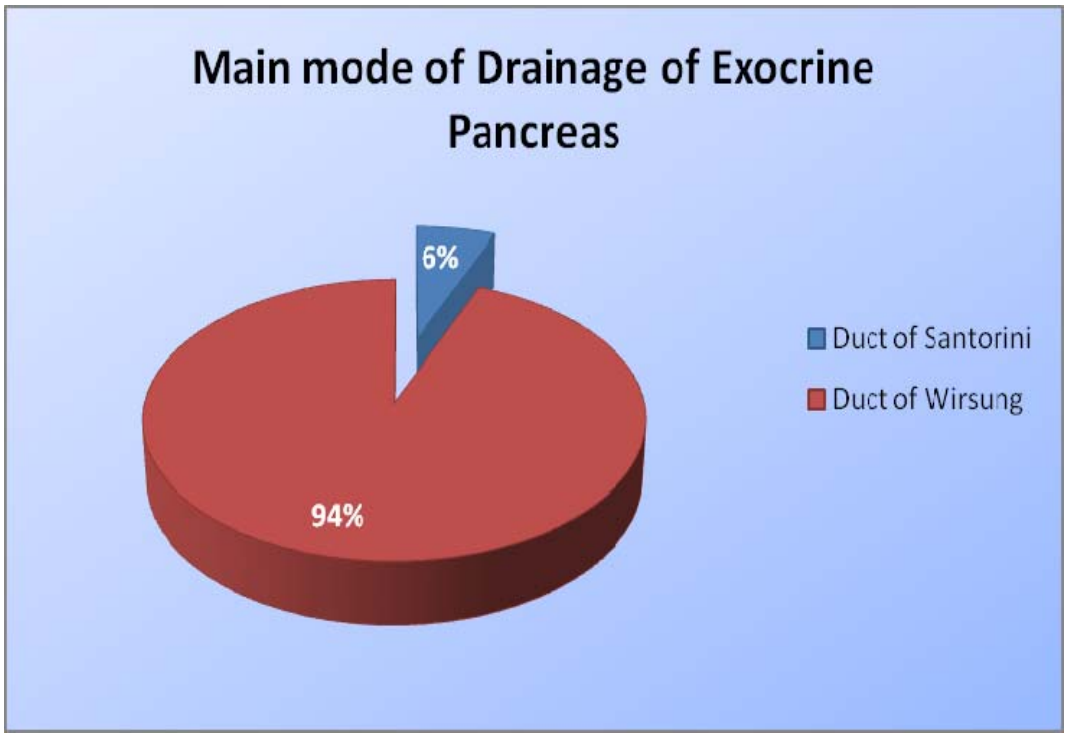
### 1. Main mode of drainage of exocrine pancreas (Table No.I)

The observations made in this aspect during the present study were tabulated in the Table No.1. From this the following data were obtained. Out of total 50 specimens studied, duct of wirsung is the main mode of drainage in 47 of the total specimens. Duct of santorni is the main mode of drainage in 3 specimens out of Total 50 specimens.

**Table No: I**

**Mode of drainage of exocrine pancreas**

| | | **Percentage** |
|---|---|---|
| **Number of specimens studied** | **50** | **100%** |
| **Duct of wirsung as the main mode** | **47** | **94%** |
| **Duct of santorini as the main mode** | **3** | **6%** |



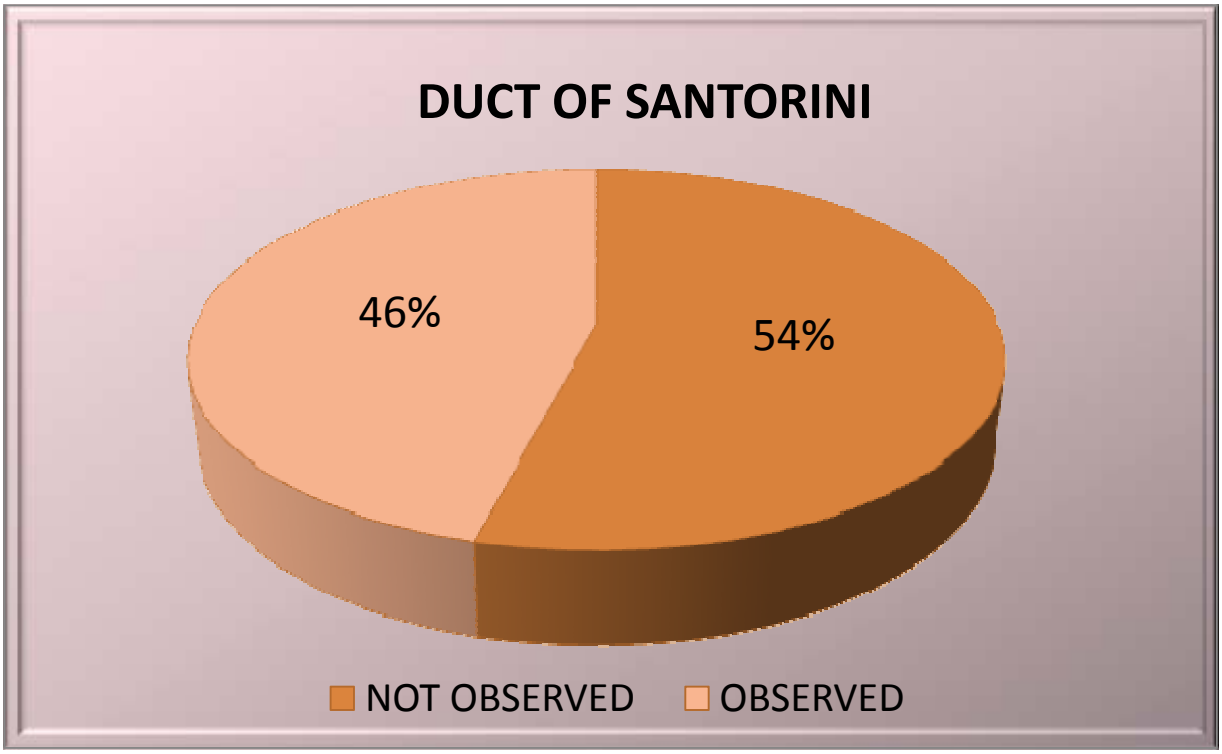

2) In specimens where the duct of wirsung is the main mode of drainage, the duct of Santorini was also observed during the dissection. For this study only dissected specimens were used.

Among the total 50 specimens where the main mode drainage was the duct of Wirsung, the accessory pancreatic duct was found in 23 cases.

**Table No: II**

## *Duct of santorini*

| | | Percentage |
|---|---|---|
| **Specimens studied** | **50** | **100%** |
| **Duct of santorini observed** | **23** | **46%** |



## D) Patency of the Pancreatic ducts

1) Main pancreatic duct was observed as patent in all cases.
2) Among the specimens where the accessory was not the main mode of drainage its patent communication with duodenum was observed as follows (Table No. III). For this study only dissected specimens were used . In total, out of 50 specimens studied in this group 12 showed a patent communication of Accessory pancreatic duct with duodenum (Figure 4).

**Table No. III**

***Patency of Accessory duct with duodenam***

| | | **Percentage** |
|---|---|---|
| **Specimens studied** | **50** | **100%** |
| **Accessory having patent communication with duodenum** | **12** | **24%** |

## E) Distance between major and minor duodenal papillae

For measuring the distance between the two duodenal papillae only the dissected specimens were taken. Among 50 specimens studied the average distance between the two papillae was calculated as 15mm. The distance varies from 10mm to 20mm (Figure 5).

## F) Retropancreatic positioning of bile duct

### 1) Accessibility of bile duct (Table No. IV)

Out of the total 50 specimens studied in this category 30 specimens showed a freely accessible bile duct in the retropancreatic position and 20 specimen showed not freely accessible bile duct (Figure 9).

**Table No. IV**

***Retro pancreatic positioning of bile duct***

| | | **Percentage** |
|---|---|---|
| **Specimens studied** | **50** | **100%** |
| **Freely accessible** | **30** | **60%** |
| **Not freely accessible** | **20** | **40%** |

II) According to the observations the freely accessible bile duct which was noted in 30 specimens can be divided in to 2 groups (Table No.V).

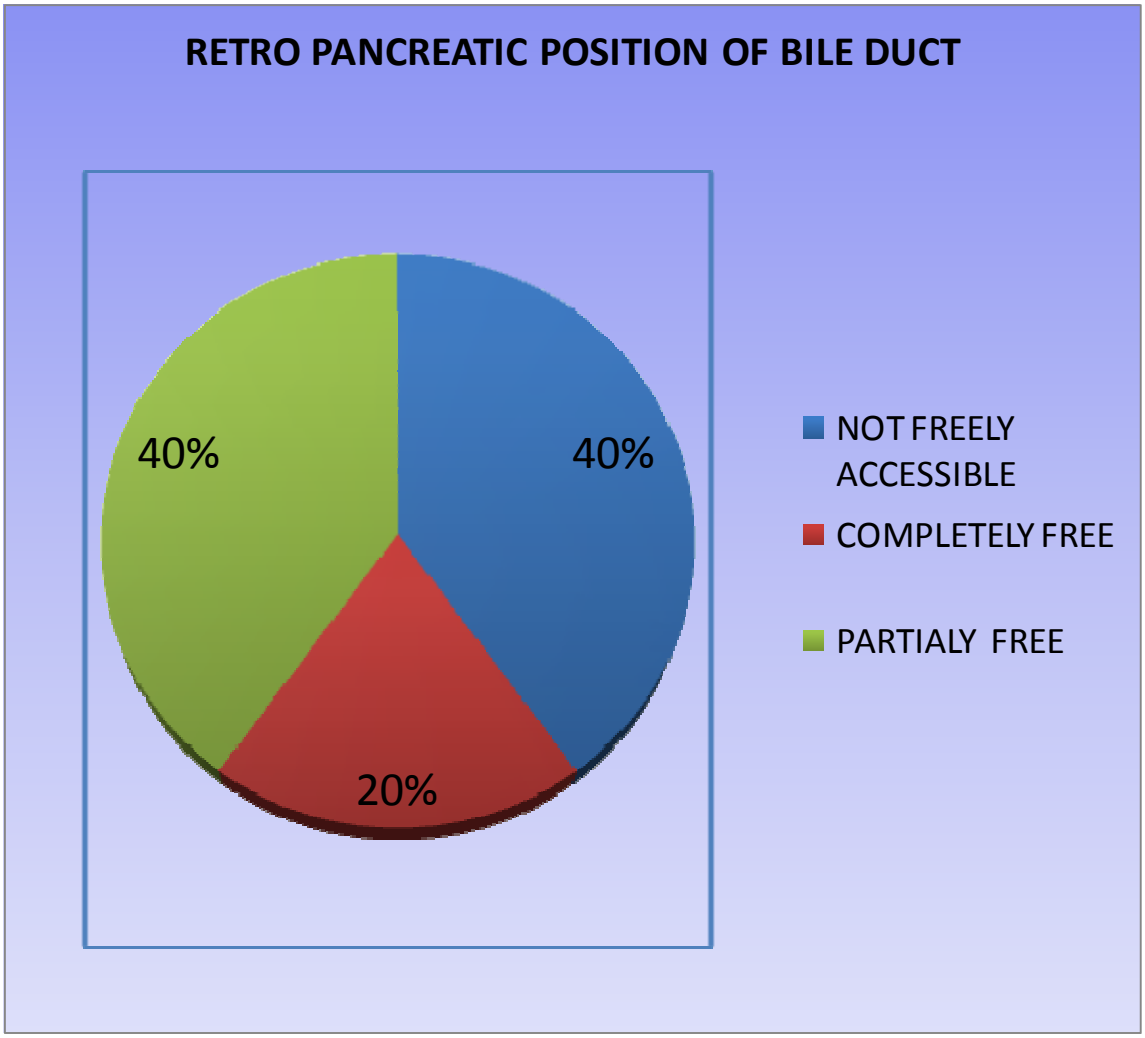
1) Completely free readily accessible retropancreatic bile duct.
2) Retropancreatic bile duct which was freely accessible but covered by a thin pancreatic tissue.

Among the thirty specimens 1) Retropancreatic bile duct was completely free in twenty specimen i.e. group 1 (Figure 7). Ten specimens showed a thin pancreatic tissue covering the retro pancreatic bile duct i.e. group II (Figure 8).

**Table V**

***Freely accessible retro pancreatic bile duct***

| | | **Percentage** |
|---|---|---|
| **Specimens studied** | | |
| **Freely accessible retro pancreatic bile duct** | **30** | **100%** |
| **Completely free (Group-I)** | **20** | **66%** |
| **Covered by thin pancreatic tissue (Group-II)** | **10** | **34%** |

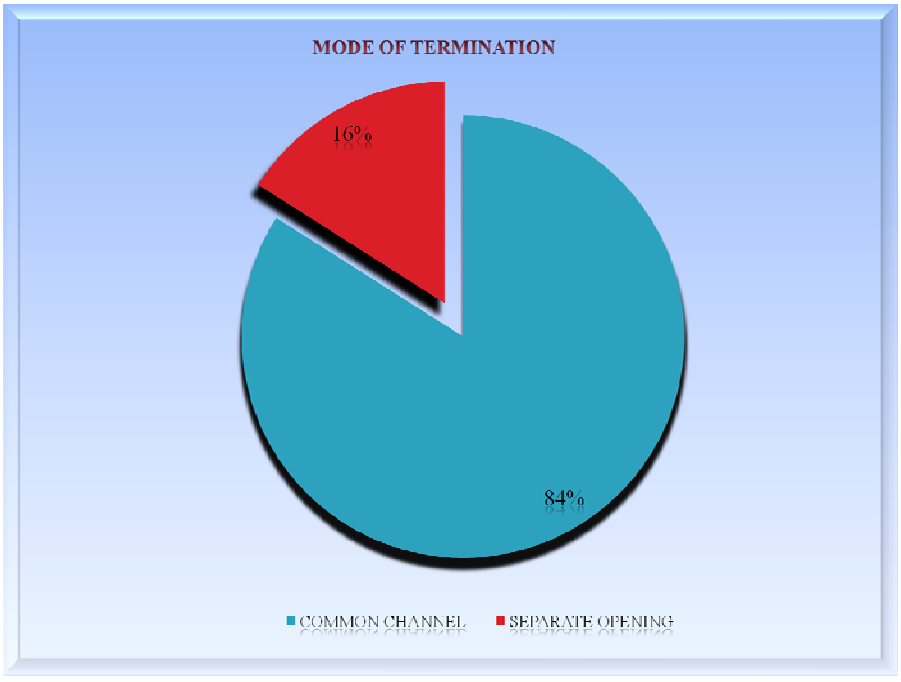

RETRO PANCREATIC POSITION OF BILE DUCT
40%
40%
20%
NOT FREELY ACCESSIBLE
COMPLETELY FREE
PARTIALY FREE

**G) Mode of termination of common bile duct and pancreatic duct (Table No.VI)**

**Table No. VI**

***Mode of termination of common bile duct and pancreatic ducts***

| | | Percentage |
|---|---|---|
| **Specimens studied** | **50** | **100%** |
| **Common channel** | **42** | **84%** |
| **Separate openings** | **8** | **16%** |



For this study only dissected specimens were used. The main pancreatic duct and the common bile duct opened through a common channel in 42 out of 50 specimens.

Separate openings were noted in 8 specimens out of 50 specimens constituting of total specimens (Figure 10 & 11).

## H) Length of the common channel (Table No.VII )

Only dissected specimens were used for measuring the length of common channel. In this study out of total 50 specimens 42 specimens showed a common channel for the bile duct and pancreatic duct. So for measuring the length of common channel only 42 specimens were taken.

The observations were tabulated in 3 groups.

The Group I is where the length of common channel was measured to a maximum of 3 mm (Figure 12 & 13). This was observed in 24 specimens.

In the Group II the length measured was more than 3mm and to a maximum of 12 mm (Figure 14). The length of common channel measured in 17 specimens came under this group.

The Group III is where the common channel length has to be more than 12mm which was observed only in one specimen (Figure 15).

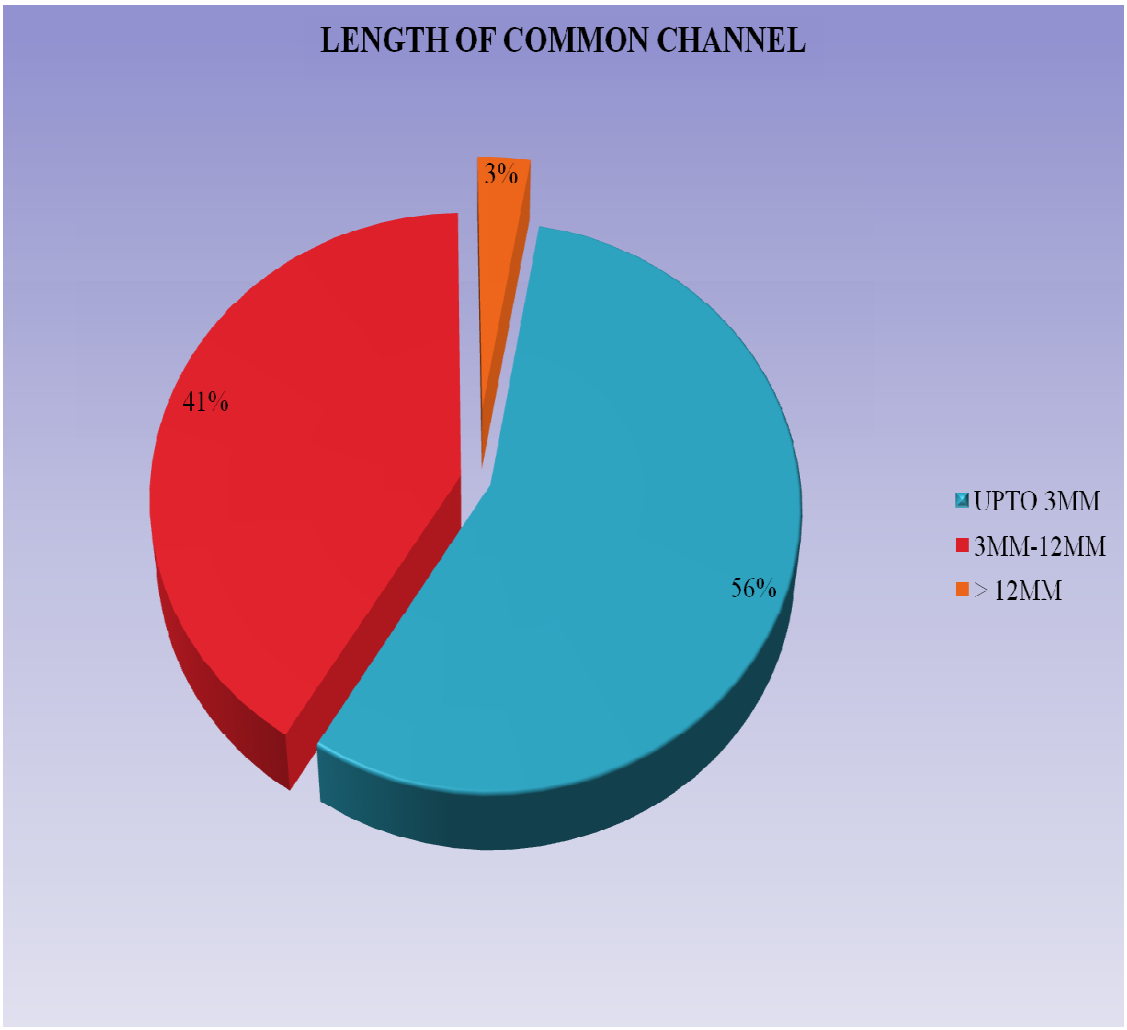
From the Table No.VII it is evident that totally 18 specimens showed a common channel length of more than 3 mm length.

In one specimen the length of the common channel was measured as 15mm. In this type the junction was noted as of a P-B type (Pancreatic-Biliary type).

**Table No.VII**

## *Measured length of the common channel*

| | | **Percentage** |
|---|---|---|
| **Specimens studied** | **42** | **100%** |
| **Length of the common channel** | | |
| **Upto 3 mm (Group –I)** | **24** | **56%** |
| **More than 3mm and less than or equal to 12 mm (Group – II)** | **17** | **41%** |
| **Greater than 12 mm (Group – III)** | **1** | **3%** |


LENGTH OF COMMON CHANNEL
3%
41%
56%
UPTO 3MM
3MM-12MM
> 12MM

# DISCUSSION

## Ductal pattern of Pancreas

### A) Mode of formation and position of Pancreatic Ducts

In the present study, the main pancreatic duct is noticed, as it is commencing at the tail end of the pancreas and is nearer to the posterior surface towards the superior border. The secondary ducts are draining at the right angle to the main duct to form the characteristic ‘herring bone’ pattern. Main duct is receiving branches from tail, body, neck and postero inferior part of head and uncinate process of pancreas. Accessory duct when it is noticed is placed anterior as well as cranial to the Main pancreatic duct. It receives branches from antero inferior part and upper part of the head.

The same pattern was described by Cameron (1924), Nebour (1931) Reinholf and Pickrell (1945) and Erik Millbourn (1950). Similar observation was described by Willasrumec and Pongichireek (1999) in Thai people. The patterns observed in the present study is correlating with the pattern described in the Gray’s Anatomy ($39^{th}$ Edition) and is the same.

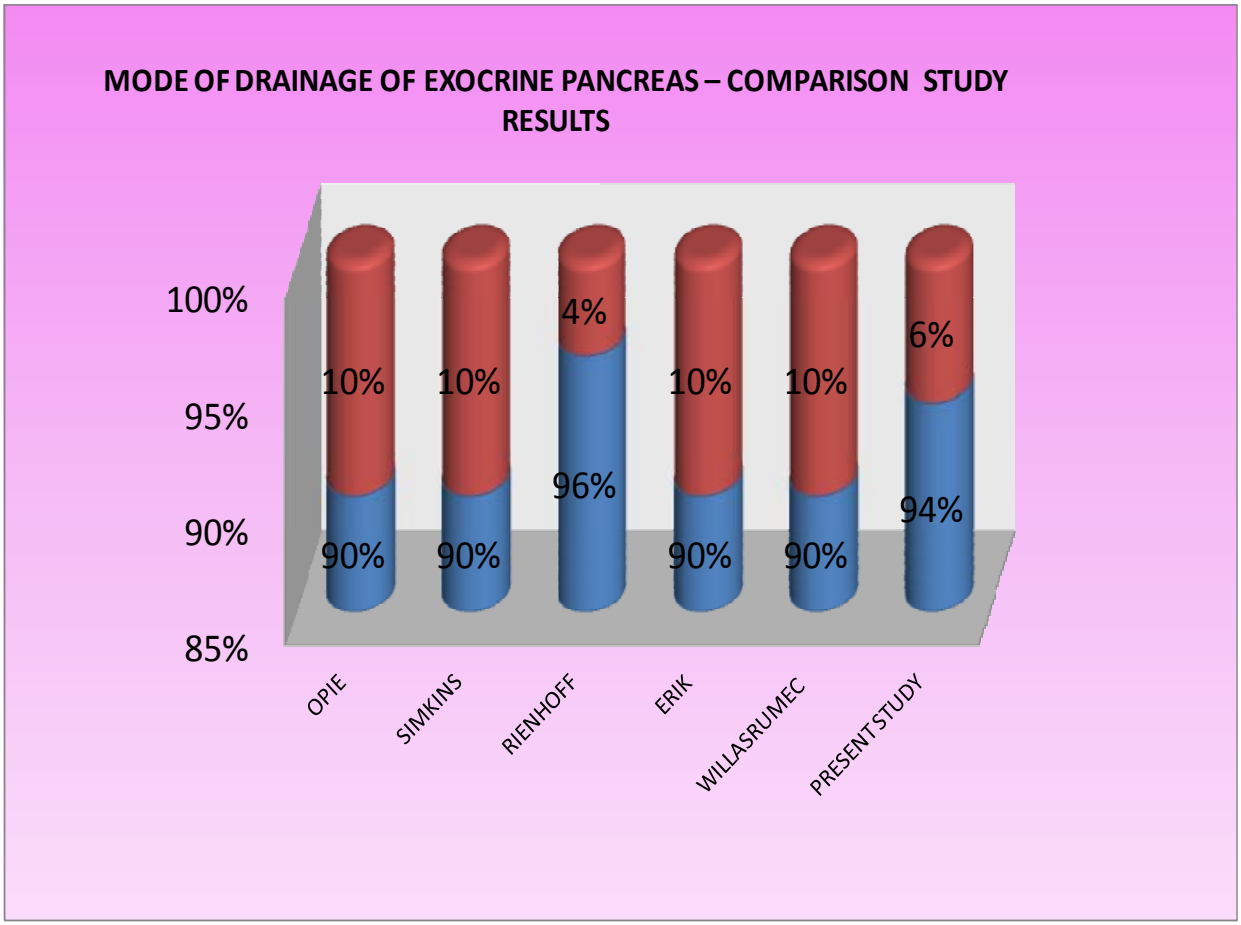
## B) Mode of drainage of Exocrine Pancreas

**Table No. VIII**

**Mode of drainage of exocrine pancreas –**

**Comparison study of with previous study results**

| Study | Wirsung duct as the main duct | Accessory duct as the main duct |
|---|---|---|
| **OPIE (1903)** | **90%** | **10%** |
| **SIMKINS (1911)** | **90%** | **10%** |
| **RIENHOFF & PICKRELL (1945)** | **96%** | **4%** |
| **ERIK MILBOURN (1950)** | **90%** | **10%** |
| **WILLASRUMEC (1999)** | **90%** | **10%** |
| **PRESENT STUDY** | **94%** | **06%** |




In 1903 Opie had pointed out that in 10% cases the duct of Santorini is acting as the chief outlet and in 90% of cases the Duct of wirsung is the main mode of excretion. Same observation was made by Simkin's in 1931 and Erik Millbourn in 1950. In a study conducted in Thai people (1999) by Willasurmec and Pongichirecks.P, the report showed that in 90% people the main route of execretion is the duct of

wirsung and in the remaining 10% cases the Duct of Santorini is the main mode of excretion.

Present study shows that in 94% cases the Duct of Wirsung is the main mode of drainage of exocrine pancreas and in 06% cases duct of santorini is the main mode of drainage.

Thus the present study results are correlating with the above mentioned work results.

Rienhoff and Pickrell (1945) in their study showed that in 96% of cases the main mode of drainage is the Duct of Wirsung and in only 4% of Duct of Santorini is the main excretory route. The present study result shows a higher value (06%) where the duct of santorini is the main excretory route compared to the Rienhoff study. And compared to his study the percentage of cases where the Duct of wirsung is the main mode of drainage shows a lower value in the present study (94%).

**Surgical Importance**

In cases where the Accessory Duct is the chief outlet care should be taken to avoid injuries to it when mobilizing the proximal part of duodenum for surgeries like partial gastrectomy. These type of patients,

where the Accessory Duct is the chief outlet, may not be symptomatic in obstructive lesions of Main Pancreatic duct.

Present study shows in cases where the Duct of Wirsung is the main excretory route, the presence of Duct of Santorini is noted by dissection in 46% cases. This result is in close approximation to the result shown by Erik Millbourn (1950) where he noted the same in 50% cases.

## C) Patency of Pancreatic Ducts

Main Pancreatic duct was found to be patent in all specimens in this present study.

Apart from the specimens where it is acting like the chief outlet, the accessory pancreatic duct is having a patent communication with duodenum in 24% of specimens. The present study doesn't show a strong correlation of patency of accessory pancreatic duct as shown by Erik Millbourn's results who noted a percentage of 50 for the same. If the air injected in the distal end of the main pancreatic duct and air bubble appearing first at the minor duodenal papilla, accessory pancreatic duct is considered as the chief outlet of exocrine pancreas.

## Distance between the major and minor duodenal papillae

The average distance between major and minor duodenal papillae was measured as 20mm in the present study. The distance varies from 15mm to 30mm.

The present study report coincides with results noted by Baldwin (1911) and Millbourn (1950) where they noted the average distance between major and minor duodenal papillae as 20mm in their studies.

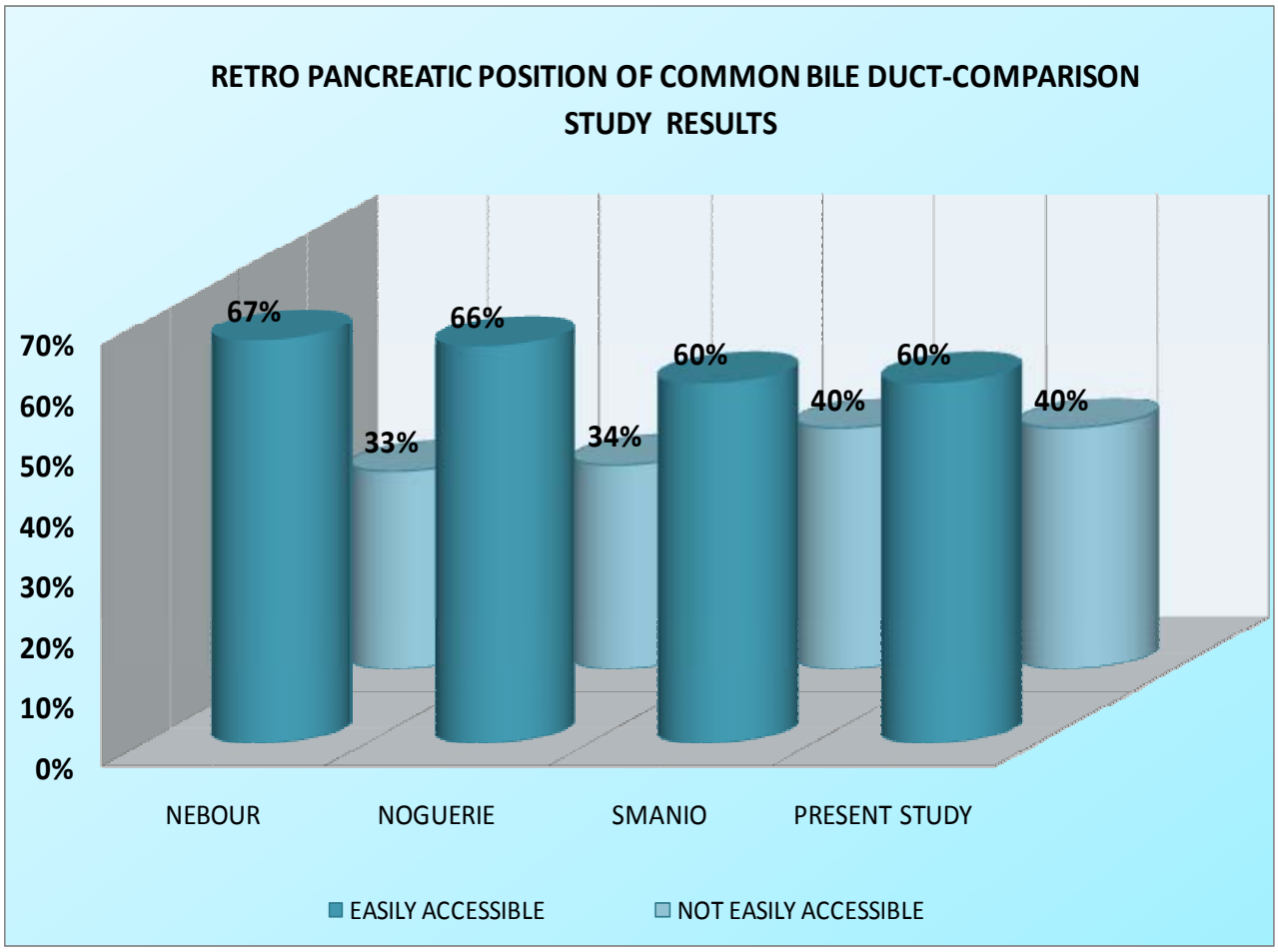
The present study result is also is very close to the study result of 21mm noted by Higress and Kernelt of Australia (1954).

## Retropancreatic position of common bile duct

**Table No. IX**

**Retro pancreatic positioning of bile duct comparison of present results with previous study results**

| Study | Easily accessible | Not freely accessible |
|---|---|---|
| **NEBUOR (1931)** | **67%** | **33%** |
| **NOGUERIE (1944)** | **66%** | **34%** |
| **SMANIO (1954)** | **60%** | **40%** |
| **PRESENT STUDY** | **60%** | **40%** |




Nebuor (1931) reported that in 67% cases the retropancreatic duct was easily accessible and in 33% it was not freely accessible. In study reports given by Nogueria (1944) and Fritas (1945) they showed in 66% cases retro pancreatic bile duct was easily accessible and in 34% it was not freely accessible. Again Smanio (1954) in his study showed in 60%

cases the retro pancreatic bile duct was being covered by a thin lamina of pancreatic tissue or only by connective tissue and so it was easily accessible. In the remaining 40% he noticed ‘not freely accessible’ retropancreatic bile duct.

In the present study 60% showed an easily accessible retropancreatic bile duct and in 40% it was not freely accessible.

Present study results are in close relation with study results showed by the above mentioned workers.

**Surgical Importance**

From the present study results, it is evident that in 60% cases the exploration of retropancreatic bile duct is very easy in Biliary surgeries for an impacted gall stone or strictures in the bile duct.

## Termination of Common Bile Duct and pancreatic duct

According to the present study results 84% of the specimens had a common channel for biliary and pancreatic output and 16% showed separate openings.

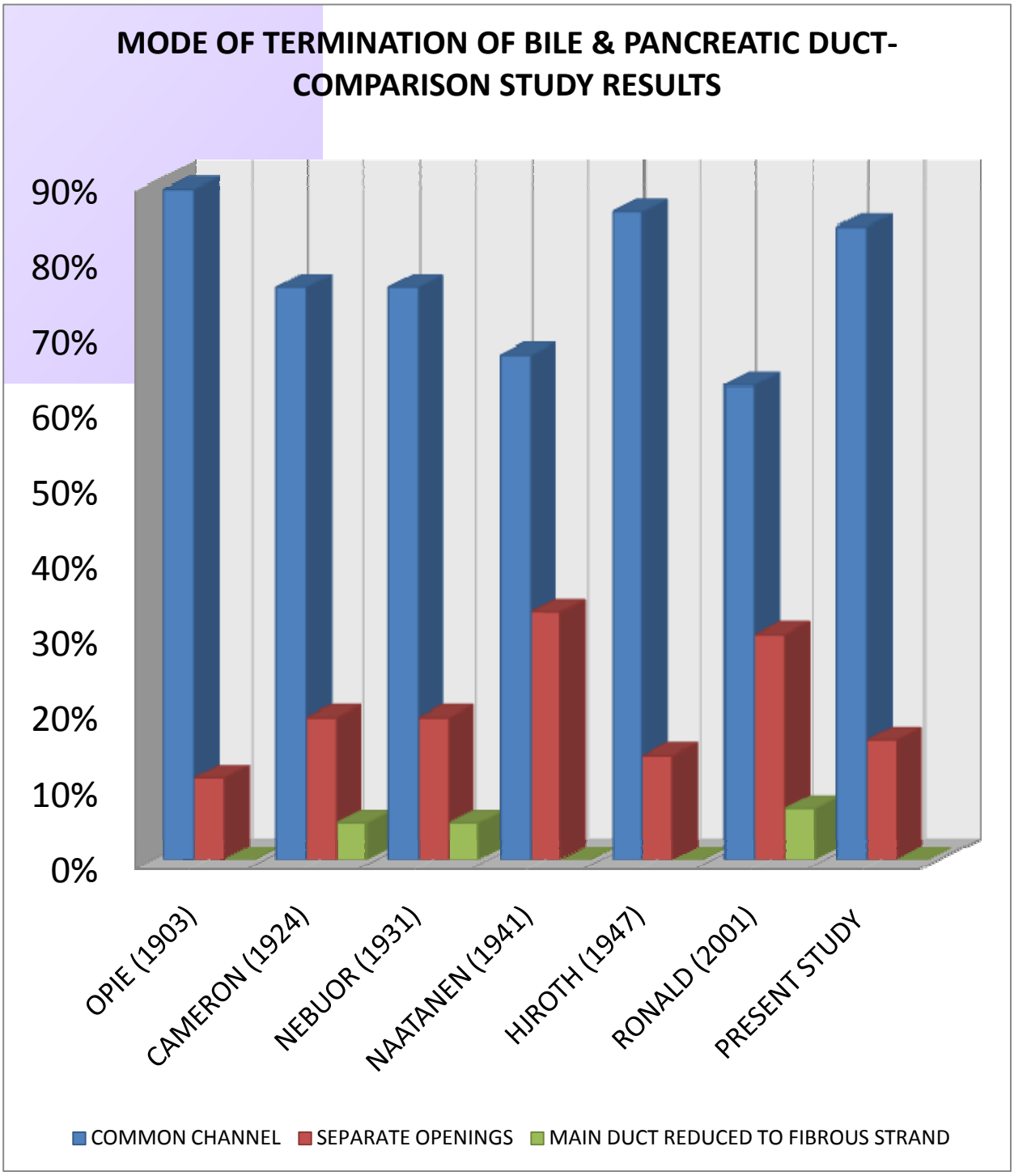
Opie (1903) noted the presence of a common channel in 89% and separate openings in 11%. Cameron (1924) and Nebuor (1931) showed

the presence of common channel in 76% and separate openings in 19% and in the remaining specimens main duct reduced to a fibrous strand. Hjroth (1947) in his study result quoted a percentage of 86 for the common channel and 14% for the separate openings.

**Table No. X**

**Mode of termination of common bile duct and pancreatic duct – comparison of present study with previous studies**

| Study | Common channel | Separate openings | Main duct reduced to a fibrous strand |
|---|---|---|---|
| **OPIE (1903)** | **89%** | **11%** | **-** |
| **CAMERON (1924)** | **76%** | **19%** | **5%** |
| **NEBUOR (1931)** | **76%** | **19%** | **5%** |
| **NAATANEN (1941)** | **67%** | **33%** | **-** |
| **HJROTH (1947)** | **86%** | **14%** | **-** |
| **RONALD (2001)** | **63%** | **30%** | **7%** |
| **PRESENT STUDY** | **84%** | **16%** | **-** |


MODE OF TERMINATION OF BILE & PANCREATIC DUCT-COMPARISON STUDY RESULTS
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
OPIE (1903)
CAMERON (1924)
NEBUOR (1931)
NAATANEN (1941)
HJROTH (1947)
RONALD (2001)
PRESENT STUDY
COMMON CHANNEL
SEPARATE OPENINGS
MAIN DUCT REDUCED TO FIBROUS STRAND

The present study results are in close relation to the above mentioned work results.

Naatanen (1941), in his study noted the presence of common channel in 67% and in separate openings in 33%. In a study conducted by Ronald A.Berger (2001) he showed that 63% of specimens had a common channel for bile and pancreatic ducts and 30% showed separate openings. These results are not coinciding with present study results.

## Length of the Common Channel

The Common Channel formed by the union of main pancreatic duct and common bile duct was measured and depending upon the length of the channel, specimens were grouped into 3 categories.

In the present study 24 specimens (56%) showed a common channel with the length less than or equal to 3 mm. All the other 18 specimens (4%) with a common channel showed a length more than 3 mm.

According to Reinhoff and Pickrell (1945) Bruce, Valmikey and Ross (1979) an ampulla cannot be described when the common channel

length is less than 3mm. So in the present study group only in 18 specimens ampulla can be defined.

**Clinical Correlation**

This people with a long common channel is prone for reflux pancreatitis when there is an obstructive lesion in the common channel either due to tumor or stone.

One more group is defined in this study where the common channel is having a length more than 12mm. In this group only one specimen where a common channel with the length of 15mm was noticed. A Japanese study group (1994) described this condition, where common channel length is more than 12mm, as Anomalous Pancreatico Biliary Ductal Union (APBDU) which is a congenital anomaly. They described 2 types of APBDU.

1. Pancreatic – biliary type (P-B type)
2. Biliary – pancreatic type (B-P type)

In the present study APBDU noted was of P-B type.

The known associations of APBDU include bile duct cancer, gall bladder cancer and gall bladder adenomatosis. Associations were noted

for B-P type with choledochal cyst and P-B (type noticed in this study) with gall bladder cancer and biliary pancreatitis.

Finally, the average length of the common channel noted in this study group is from 15mm.

Archibald (1919) noted the average length of common channel as 2 mm. The present study result is not coinciding with the above worker.

Naatnan (1941) noted the average length of common channel as 6mm in his study. K.B. Chauch C.K.Yap and H.S. Nag (2000) in their study based on Singapore population quoted an average length of 4.5mm for the common channel.

The present study result is closely related to the above mentioned works.

# CONCLUSION

The present study included postmortem specimens too. From the study the following conclusions arrived.

1. The main pancreatic duct was commencing in the tail end of the organ and lying in the posterior surface close to the superior border in all the specimens.
2. Forty seven specimens showed the duct of wirsung as the main route of drainage and the duct of santorini in three specimens.

   This shows that surgical procedures in the proximal part of duodenum should be carried out carefully in order to avoid injury to the accessory duct, as sometimes it may be the chief outlet of exocrine pancreas.
3. The accessory duct was found to have a patent communication with duodenum in twelve specimens.
4. The average distance between major and minor duodenal papillae is 15mm. In fifteen cases it is 15-20mm, in eight cases it is 10-15mm and in remaining twenty seven cases there is absence of minor papillae.

5. The bile duct was freely accessible in retro pancreatic position in thirty cases and was deeply buried in the pancreatic tissue in twenty cases. The above finding is useful to the surgeons during the extraction of gall stones and in stricture surgeries.
6. Forty two specimens showed a common channel and eight specimens showed separate opening in the duodenum for bile duct and pancreatic duct. When the common channel was measured seventeen specimens showed a channel length more than 3mm and twenty four specimens showed a channel length upto 3mm. This study results shows that almost half of the people with common channel are at high risk for reflux pancreatitis.

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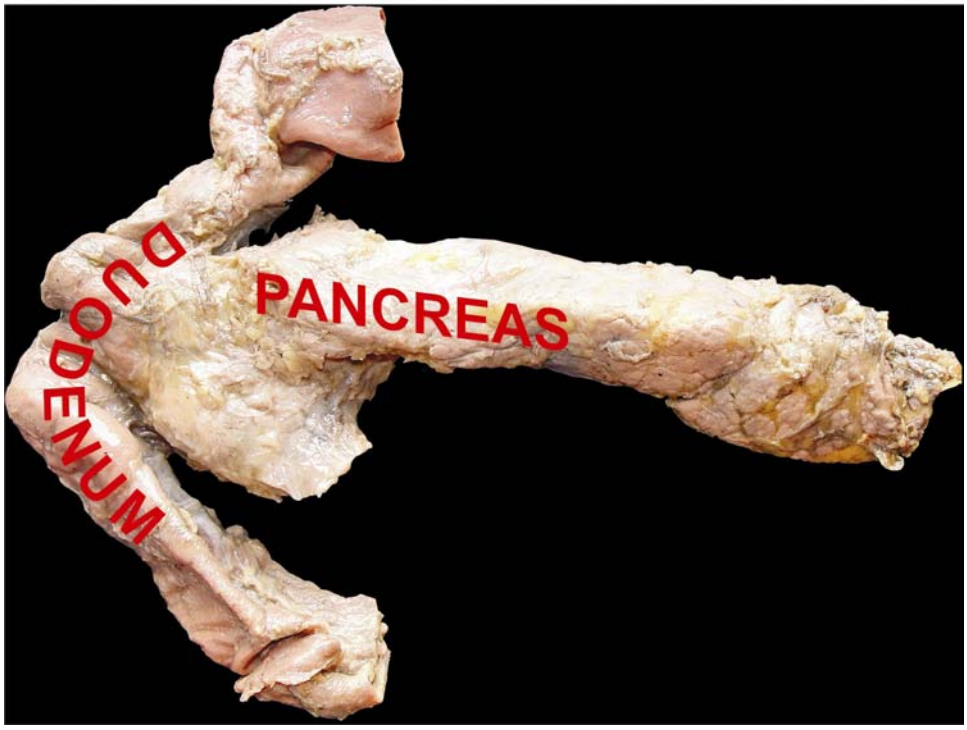
**Figure 1**

Total No. of Specimens - 50

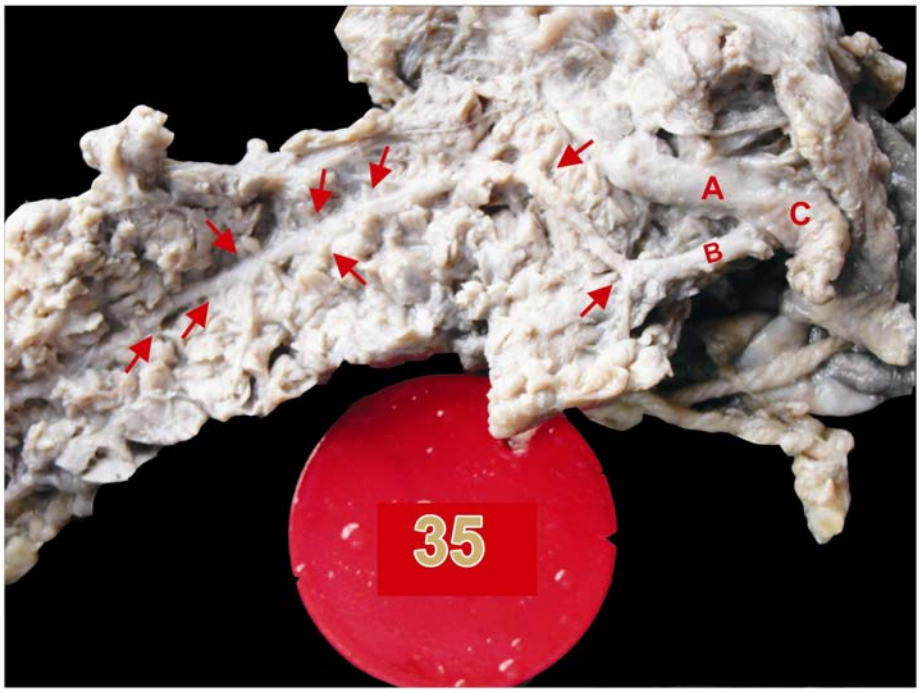
**Figure 2**

Pancreas with Duodenum



## Figure 3

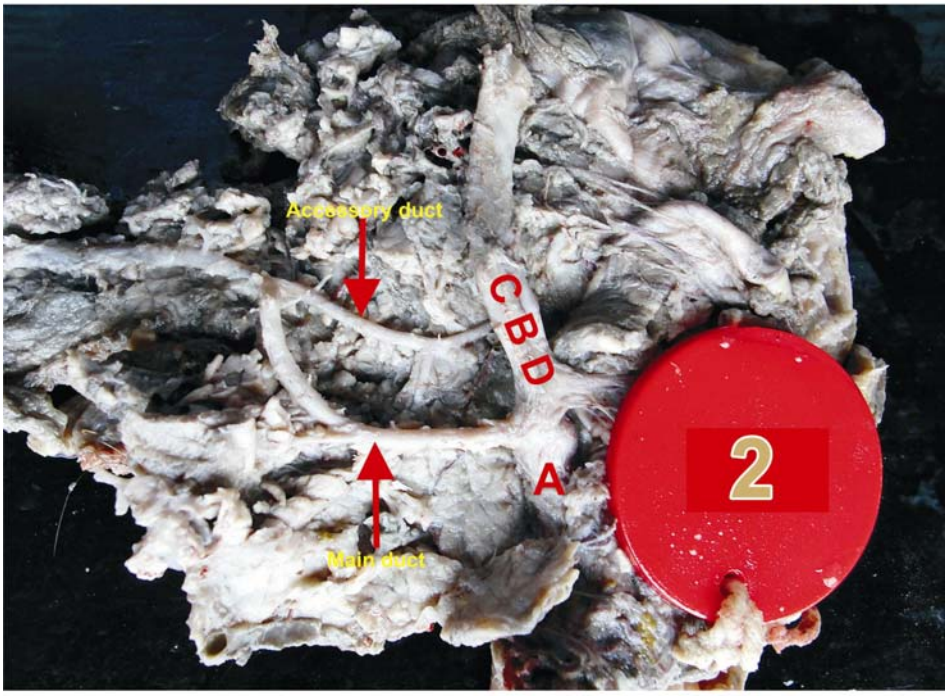
### Herring Bore pattern




A - common Bile duct  B - Pancreatic duct  C - Pancreaticobilliary duct.

## Figure 4

### Patent Main and accessory Pancreatic duct



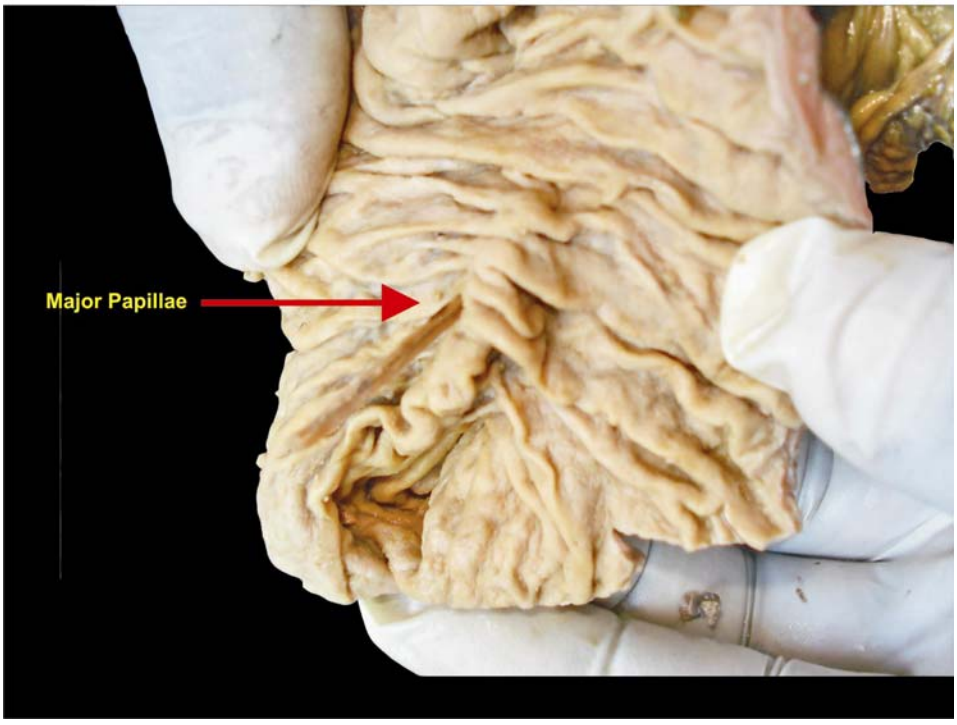

CBD - Common Bile duct  A - Pancreatiobiliary duct.

**Figure 5**

Major and Minor Papillae


**Figure 6**

Major Papillae without Minor Papillae



## Figure 7


CBD - Common Bile duct

## Figure 8

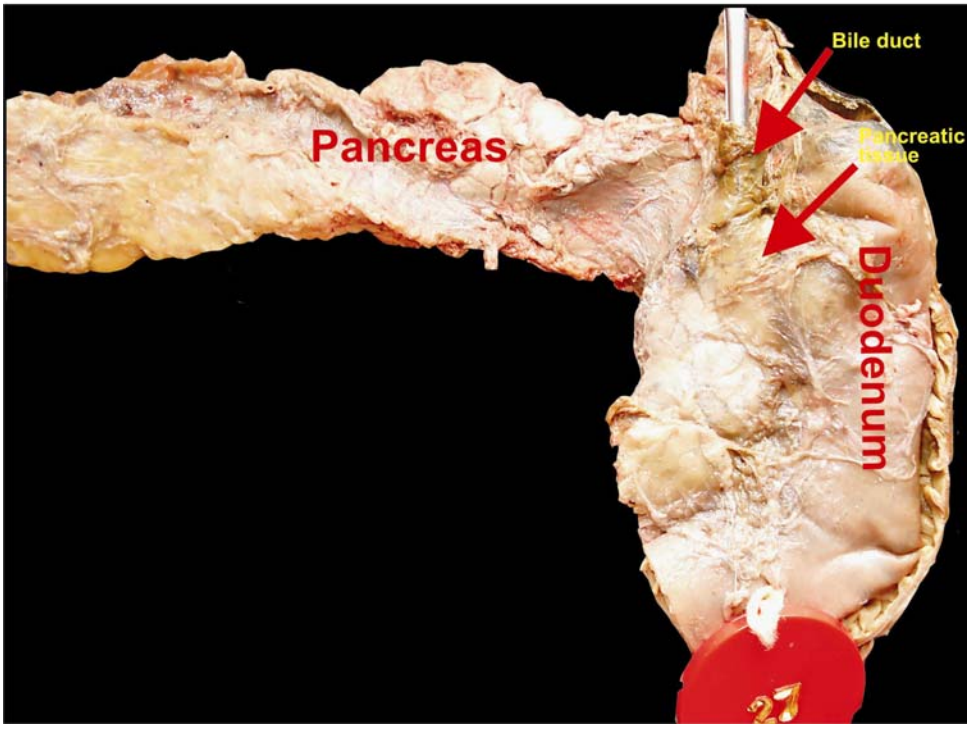


**Figure 9**

**Not Freely accesible Bile duct**

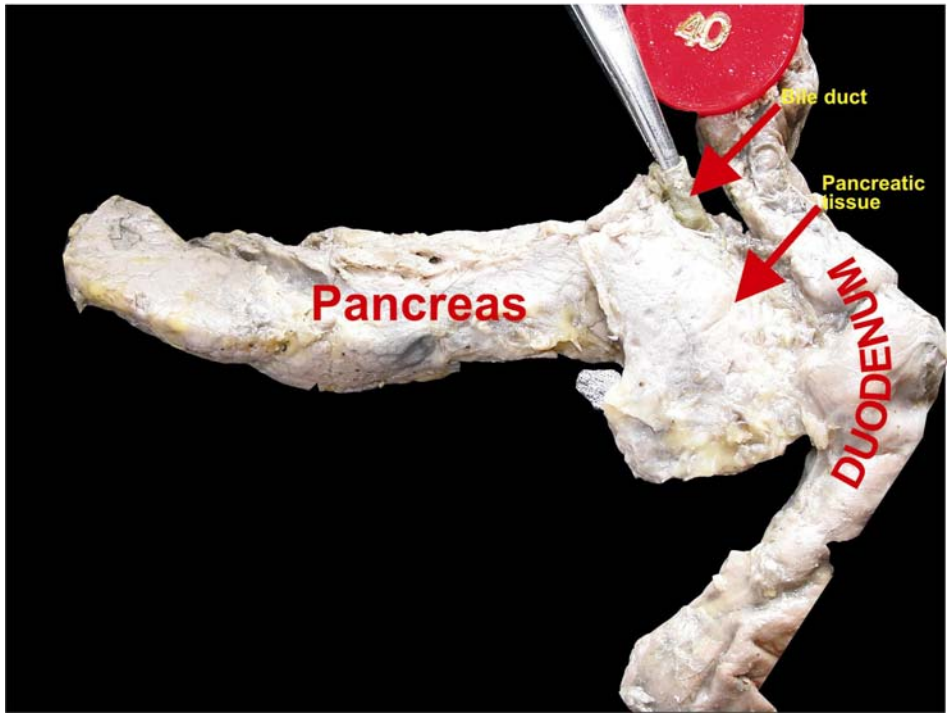
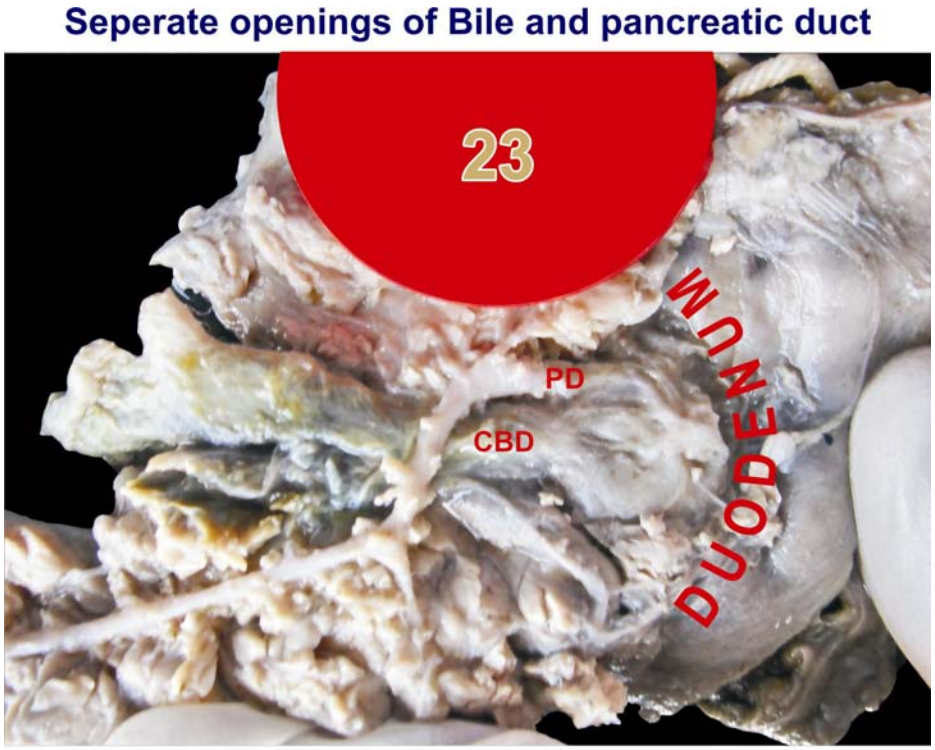



**Figure 10**

**Seperate openings of Bile and pancreatic duct**

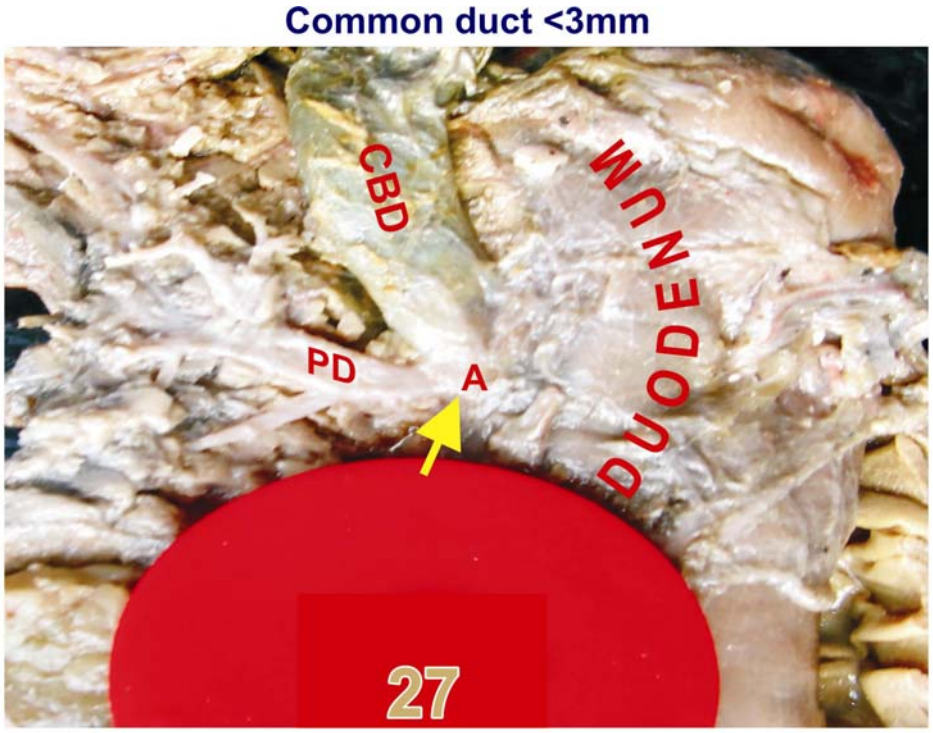

A - Bile duct B - Pancreatic duct

## Figure 11




CBD - Common Bile duct PD-Pancreatic duct

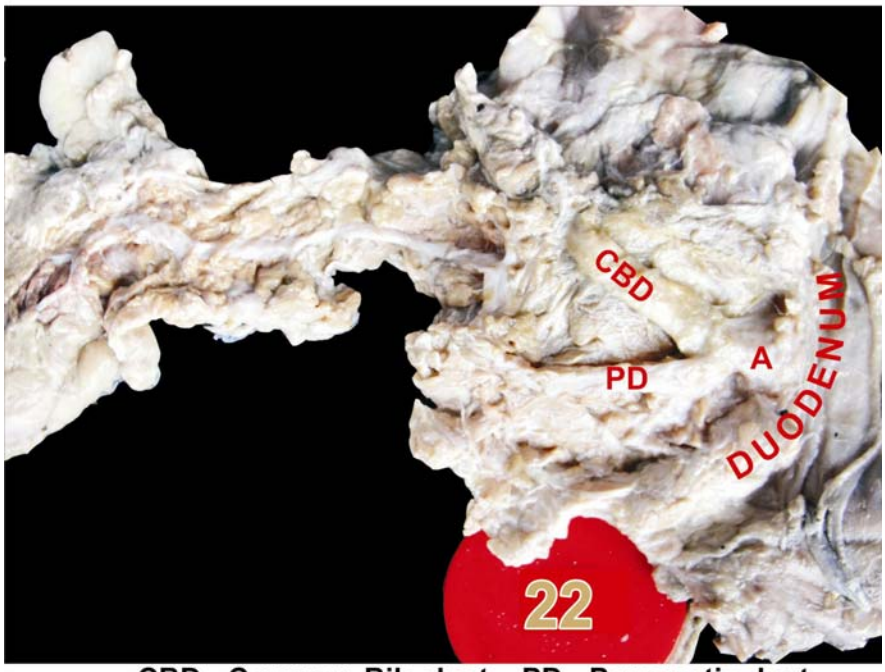
## Figure 12




CBD - Common Bile duct PD - Pancreatic duct A - Pancreaticobiliary duct.

## Figure 13

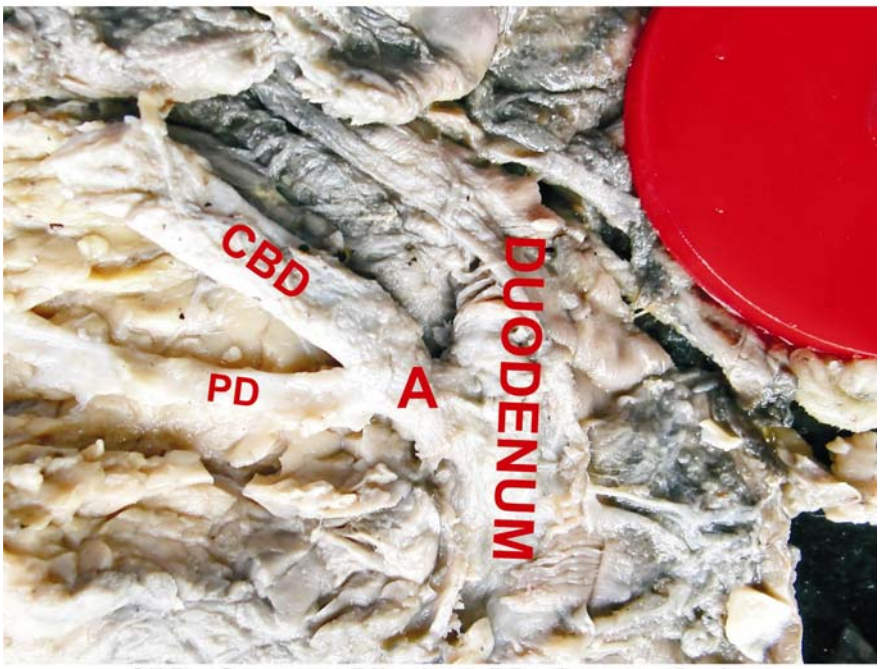
**Common duct <3mm**




CBD - Common Bile duct PD - Pancreatic duct
A - Pancreaticobiliary duct

## Figure 14

**Common duct - 3 to 12 mm**




CBD - Common Bile duct PD - Pancreatic duct
A - Pancreaticobiliary duct

**Figure 15**

Common duct > 12 mm


CBD - Common Bile duct PD - Pancreatic duct
A - Pancreaticobiliary duct

## Master Chart

| S.No | Formation | Position of MPD | Position of APD | Main Mode of Drainage | | Presence of Santorini | Patency of santorini | Distance b/w major & minor duodenal papillae | Retropancreatic bile duct Accessibility | | | Mode of termination of bile duct | | Length of common channel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Duct of Wirsung | Duct of Santorini | | | | Freely | | Not Freely | Common channel | Separate Opening | | | |
| | | | | | | | | | C | NC | | | | <3mm | 3-12mm | >12mm |
| 1 | Herring Bore | PSB | CV | + | - | + | - | 15mm | + | - | - | + | - | - | + | - |
| 2 | Herring Bore | PSB | CV | + | - | + | + | 20mm | - | - | + | + | - | - | - | + |
| 3 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | + | - | - |
| 4 | Herring Bore | PSB | CV | - | + | + | + | 17mm | - | + | - | + | - | + | - | - |
| 5 | Herring Bore | PSB | CV | + | - | + | - | 18mm | + | - | - | - | + | - | - | - |
| 6 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 7 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | + | - | - |
| 8 | Herring Bore | PSB | CV | - | + | + | + | 15mm | - | - | + | + | - | + | - | - |
| 9 | Herring Bore | PSB | CV | + | - | + | + | 18mm | - | - | + | - | + | - | - | - |
| 10 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | + | - | - |
| 11 | Herring Bore | PSB | CV | + | - | + | - | 20mm | + | - | - | - | + | - | - | - |
| 12 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 13 | Herring Bore | PSB | - | + | - | - | - | - | - | + | - | + | - | + | - | - |
| 14 | Herring Bore | PSB | CV | + | - | + | + | 13mm | + | - | - | + | - | + | - | - |
| 15 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | - | + | - |
| 16 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | + | - | - |
| 17 | Herring Bore | PSB | CV | + | - | + | - | 12mm | - | - | + | + | - | - | + | - |
| 18 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | - | + | - |
| 19 | Herring Bore | PSB | CV | + | - | + | + | 14mm | - | + | - | - | + | - | - | - |
| 20 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 21 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 22 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | - | + | - |
| 23 | Herring Bore | PSB | CV | + | - | + | - | 19mm | - | - | + | - | + | - | - | - |
| 24 | Herring Bore | PSB | CV | + | - | + | + | 20mm | - | + | - | + | - | - | + | - |
| 25 | Herring Bore | PSB | CV | + | - | + | - | 16mm | - | + | - | + | - | - | + | - |
| 26 | Herring Bore | PSB | - | + | - | - | - | - | - | + | - | + | - | - | + | - |
| 27 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | + | - | - |
| 28 | Herring Bore | PSB | CV | + | - | + | - | 18mm | - | + | - | + | - | + | - | - |
| 29 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 30 | Herring Bore | PSB | CV | + | - | + | - | 16mm | + | - | - | + | - | - | + | - |
| 31 | Herring Bore | PSB | CV | - | + | + | - | 10mm | + | - | - | + | - | - | + | - |
| 32 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 33 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | - | + | - |
| 34 | Herring Bore | PSB | CV | + | - | + | + | 15mm | - | + | - | - | + | - | - | - |
| 35 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | - | + | - |
| 36 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | - | + | - |
| 37 | Herring Bore | PSB | CV | + | - | + | + | 13mm | + | - | - | + | - | + | - | - |
| 38 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 39 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | - | + | - |
| 40 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | + | - | + | - | - |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | Herring Bore | PSB | CV | + | - | + | + | 18mm | - | - | + | + | - | + | - | - |
| 42 | Herring Bore | PSB | - | + | - | - | - | - | - | + | - | - | + | - | - | - |
| 43 | Herring Bore | PSB | CV | + | - | + | - | 16mm | + | - | - | + | - | - | + | - |
| 44 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 45 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 46 | Herring Bore | PSB | CV | + | - | + | + | 13mm | + | - | - | + | - | - | + | - |
| 47 | Herring Bore | PSB | - | + | - | - | - | - | - | - | + | + | - | + | - | - |
| 48 | Herring Bore | PSB | CV | + | - | + | + | 11mm | - | + | - | + | - | + | - | - |
| 49 | Herring Bore | PSB | - | + | - | - | - | - | + | - | - | - | + | - | - | - |
| 50 | Herring Bore | PSB | CV | + | - | + | - | 19mm | - | - | + | + | - | - | + | - |

MPD - Main Pancreatic Duct ; PSB - Posterior Surface and Superior Border ; APD - Accessory Pancreatic Duct ; C - Completely
NC - Not Completely; b/w - between ; CV - Cranio ventral

# MASTER CHART ABBREVIATIONS

| | | |
|---|---|---|
| MPD | - | Main Pancreatic Duct |
| PSB | - | Posterior Surface and Superior Border |
| APD | - | Accessory Pancreatic Duct |
| C | - | Completely |
| NC | - | Not Completely |
| b/w | - | between |
| CV | - | Cranio ventral |